

SECTION 7.14

STRUCTURAL AND AUTOMOBILE FIRES

(Updated June 1994)

EMISSION INVENTORY SOURCE CATEGORY

Miscellaneous Processes/Fires

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION

660-656-0200-0000 (47324) Structural Fires

660-658-0200-0000 (57307) Automobile Fires

METHODS AND SOURCES

These categories are used to inventory the combustion emissions from structural, mobile home, and automobile fires. **Structural fires** covers buildings and mobile home fires. **Automobile fires** covers automobile fires. The criteria pollutant emissions for 1991 are presented in Table II (**Structural Fires**) and Table III (**Automobile Fires**). Estimates of building, mobile home, and automobile fires in 1991 were based on data from an annual report generated by the California Fire Incident Reporting System (CFIRS).¹

For structural fires, structural loss is first calculated. An average percent structural loss per fire is calculated by dividing the total monetary damage due to fires¹ by the product of the average value of a residence in California² and the number of residential fires.¹ The average structural loss per fire is 7.3 percent. To determine the amount of material burned in a fire, the ARB staff contacted the National Association of Home Builders and Mr. Larson, Chief Building Inspector, City of Sacramento.² According to the National Association of Home Builders, the average residence has approximately 1,200 to 1,500 square feet of floor space and an average of 10,000 - 12,000 board feet of lumber in the structure.

ARB staff assumed an average of one ton of material per 1,000 board feet, therefore an average residence has approximately 11 tons of combustible material. With a rate loss of 7.3 percent, the structural loss is 0.80 tons per fire.

Next, content loss is calculated. The National Bureau of Standards lists the combustible contents per square foot of the functional areas of the average home.³ These figures have been multiplied by the percent of fires originally estimated to occur within each of these functional

areas ¹, and the products are then added to obtain the weighted average of 7.91 pounds per square foot.

<u>Functional Area</u>	<u>Origin of fires(%)</u>	<u>Combustibles (lbs/sq. ft.)</u>	<u>Weighted Average (lbs/sq. ft.)</u>
Bedroom	28.96	10.4	3.012
Sleeping Area	0.20	10.4	0.021
Dining Area	2.20	7.2	0.159
Kitchen	53.92	6.8	3.667
Bathroom	6.32	7.0	0.443
Laundry	8.08	7.2	0.582
Office	0.17	7.9	0.013
Other	0.13	9.6	<u>0.012</u>
			7.909

With a 7.3 percent loss rate, an average of 7.91 pounds of combustible contents per square foot, and assuming an average floor space of 1200 square feet, the content loss for the average residential fire would be:

$$[(1200) \times (0.073) \times (7.91)] / 2000 = 0.35 \text{ tons/fire}$$

$$\begin{aligned} \text{Total amount burned per residential fire} &= \text{Structural loss} + \text{content loss} \\ &= 0.80 + 0.35 = 1.15 \text{ tons/fire} \end{aligned}$$

Structural Fires (CES 47324) are apportioned among counties based on total housing units as estimated by the California Dept. of Finance (DOF) and (in some larger districts) by local government agencies. **Automobile Fires** (CES 57307) are apportioned based on the number of vehicles as estimated by the Department of Motor Vehicles. Sub-county splits between air basins are based on population estimates from DOF or local government agencies.

Structural fire emission factors in pounds per ton of material burned for TOG, CO and PM have been obtained from tests on the burning of model wood buildings. ⁴ The emission factor for NOx is assumed to be similar to that listed in AP-42 for municipal refuse. ⁵ These emission factors have been converted to units of pounds per fire using the factor of 1.15 tons/fire.

Emission Factors for Structural Fires

	<u>TOG</u>	<u>NOx</u>	<u>SOx</u>	<u>PM</u>	<u>CO</u>
Pounds/Ton	13.9	4.0	0	10.8	168.0
Pounds/Fire	27.1	7.8	0	21.1	327.6

The emission factors for automobile fires are taken from AP-42, Sections 2.2.2 and 2.4.2. Table 2.2-1 of AP-42 lists the emission factors for uncontrolled auto body incineration. These are based on automobiles that have been partially stripped (tires, seats, etc. removed). Table 2.4-1 of AP-42 lists the emission factors for open burning of automobile components. These emission factors are for upholstery, belts, hoses, and tires burned in common.

It has been assumed that tires are burned in 60 percent of the automobile fires. Composite emission factors have been calculated as a weighted average of the emission factors listed in Table 2.2-1 and 2.4-1 of AP-42. It has been assumed that the average car body weighs 3,700 pounds and the components weigh 500 pounds. The composite emission factors are listed below. Their derivation is presented in Table I.

Emission Factors for Automobile Fires (lbs/fire)

<u>TOG</u>	<u>NO_x</u>	<u>SO_x</u>	<u>PM</u>	<u>CO</u>
7.21	0.7	0	17	21.25

ASSUMPTIONS

1. The emission factors that have been derived for structural fires are also valid for mobile home fires.
2. An average residence is constructed with approximately 11 tons of combustible material.
3. An average residence covers an area of 1,200 square feet.
4. The tires are burned in 60 percent of the automobile fires.
5. The average car body weighs 3,700 pounds.
6. The components on an average car weigh 500 pounds.
7. The estimates of structural loss rate (7.3%) and content loss rate (7.91 lb/sq. ft.) continue to be applicable.

COMMENTS AND RECOMMENDATIONS

Existing emission factors have been used, although initial research indicated significant improvement could be made based on more recent information and on more thoughtful use of existing information.

Even though emission factors for mobile home fires may be significantly different from those for structural fires, few data are available; therefore, the emission factors for mobile home fires and structural fires are assumed to be the same. The emission factors for oxides of nitrogen, which are for open burning of municipal refuse, may not be the same for structural fires.

A more accurate estimate of the percentage of cars that burn completely (tires included) needs to be determined, since most emissions are associated with automobile component and tire combustion.

CHANGES IN METHODOLOGY

There is no change in the methodology for 1992.

DIFFERENCES BETWEEN 1990 AND 1991 EMISSION ESTIMATES

The differences between the 1990 and 1991 emission estimates for structural fires and automobile fires are primarily due to the difference in the numbers of fires incidents. The emissions from structural fires decreased due to new information that reduced the average loss per fire from 12.4 percent to 7.3 percent. The median value of homes in California increased slightly from \$193,360 in 1990 to \$200,660 in 1991. ²

TEMPORAL ACTIVITY

For both categories, the annual activity and the weekly activity are uniform. The daily activity occurs primarily during daylight hours.

SAMPLE CALCULATIONS

To calculate the emissions from **Structural Fires** (CES 47324), and **Automobile Fires** (CES 57307) for Sacramento County in the Sacramento Valley air basin:

Number of **Structural Fires** = 1,546
Number of **Automobile Fires** = 1,877

Emissions = [Process Rate (# of Fires)] x (Emission Factor) / 2000 lbs/ton

The process rate and emissions for Sacramento County are summarized below:

<u>Type of Fires</u>	Process Rate (# of Fires)	Emissions (tons/yr)				
		<u>TOG</u>	<u>NO_x</u>	<u>PM</u>	<u>CO</u>	<u>SO_x</u>
Structural Fires	1,546	20.90	6.00	16.30	253.20	0
Automobile Fires	1,877	6.76	0.65	15.95	19.94	0

ADDITIONAL CODES

SOURCE CATEGORY GROWTH AND CONTROL CODES

47324 GROWTH = 923, CONTROL = 99

57307 GROWTH = 900, CONTROL = 99

SOURCE CATEGORY CODE POLLUTANT SPECIATION PROFILES

47324 VOC = 600, PM = 137

57307 VOC = 600, PM = 130

SOURCE CATEGORY CODE REACTIVITY FACTORS

Not Available

REFERENCES

1. California State Fire Marshall, California Fire Incident Reporting System, 1991.
2. Telephone conversation with Jean Alcan, California Association of Realtors, 1993.
3. National Bureau of Standards, Combustible Contents in Buildings.
4. Butler, C.P. and Darley, E.E. "Fires Dynamics of Model Wood Buildings," Fire and Flammability, Vol. 3, p. 336 (October 1972).
5. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, AP-42, Section 2.2 and 2.4. (April 1973).

UPDATED BY

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Table I

Derivation of Emission Factors for Automobile Fires

The emission factors for automobile components (Table 2.4-1 of AP-42) are listed in terms of lbs/ton of components burned. If the components per car weigh 500 lbs, the emission factors for components in terms of lbs/car can be converted as show below.

$$\text{Weight of components} = 500 \text{ lbs/car} = 0.25 \text{ tons/car}$$

$$\begin{aligned} \text{PM emission factor} &= (100 \text{ lbs/ton components}) \times (0.25 \text{ tons components/car}) \\ &= 25 \text{ lbs/car} \end{aligned}$$

Emission Factors for Components (lbs/car)

<u>PM</u>	<u>CO</u>	<u>NO_x</u>	<u>SO_x</u>	<u>TOG</u>
2.0	2.5	0.1	0.0	0.91

Assuming that tires are burned in 60% of the automobile fires, the composite emission factors are calculated as follows:

$$\text{Composite EF} = [\text{EF (body)} + \text{EF (components)}] \times 0.6 + [\text{EF (body)}] \times 0.4$$

The weighted composite emission factors (with the assumption that each car weights 3,700 lbs) are listed below:

Composite Emission Factors (lbs/fire)

<u>PM</u>	<u>CO</u>	<u>NO_x</u>	<u>SO_x</u>	<u>TOG</u>
17.0	21.25	0.7	0.0	7.21

Table II
 1991 Area Source Emissions
 Activity: Unspecified Activities
 Process: Structural Fires
 Entrainment: Solid Material Combustion
 Dimn:
 CES: 47324
 Process Rate Unit: Fires

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	3	0.00	0.40	0.00	0.00	0.00
	INYO	4	0.00	0.60	0.00	0.00	0.00
	MONO	7	0.00	1.10	0.00	0.00	0.00
LC	LAKE	61	0.80	9.90	0.20	0.00	0.60
LT	EL DORADO	39	0.50	6.30	0.10	0.00	0.40
	PLACER	12	0.10	1.90	0.00	0.00	0.10
MC	AMADOR	39	0.50	6.30	0.10	0.00	0.40
	CALAVERAS	108	1.40	17.60	0.40	0.00	1.10
	EL DORADO	111	1.50	18.10	0.40	0.00	1.10
	MARIPOSA	33	0.40	5.40	0.10	0.00	0.30
	NEVADA	70	0.90	11.40	0.20	0.00	0.70
	PLACER	28	0.30	4.50	0.10	0.00	0.20
	PLUMAS	1	0.00	0.10	0.00	0.00	0.00
	SIERRA	1	0.00	0.10	0.00	0.00	0.00
	TUOLUMNE	97	1.30	15.80	0.30	0.00	1.00
NC	DEL NORTE	72	0.90	11.70	0.20	0.00	0.70
	HUMBOLDT	192	2.60	31.40	0.70	0.00	2.00
	MENDOCINO	162	2.10	26.50	0.60	0.00	1.70
	SONOMA	65	0.80	10.60	0.20	0.00	0.60
	TRINITY	4	0.00	0.60	0.00	0.00	0.00
NCC	MONTEREY	356	4.80	58.30	1.30	0.00	3.70
	SAN BENITO	21	0.20	3.40	0.00	0.00	0.20
	SANTA CRUZ	248	3.30	40.60	0.90	0.00	2.60
NEP	LASSEN	6	0.00	0.90	0.00	0.00	0.00
	MODOC	31	0.40	5.00	0.10	0.00	0.30
	SISKIYOU	32	0.40	5.20	0.10	0.00	0.30
SC	LOS ANGELES	9126	123.60	1494.80	35.50	0.00	96.70
	ORANGE	2758	37.30	451.70	10.70	0.00	29.00
	RIVERSIDE	1093	14.80	178.90	4.20	0.00	11.50
	SAN BERNARDINO	1572	21.30	257.40	6.10	0.00	16.50
SCC	SAN LUIS OBISPO	204	2.70	33.40	0.70	0.00	2.10
	SANTA BARBARA	252	3.40	41.20	0.90	0.00	2.60
	VENTURA	441	5.90	72.20	1.70	0.00	4.60
SD	SAN DIEGO	1935	26.20	316.90	7.50	0.00	20.40
SED	IMPERIAL	61	0.80	9.90	0.20	0.00	0.60
	KERN	139	1.80	22.70	0.50	0.00	1.40
	LOS ANGELES	177	2.30	28.90	0.60	0.00	1.80
	RIVERSIDE	414	5.60	67.80	1.60	0.00	4.30
	SAN BERNARDINO	371	5.00	60.70	1.40	0.00	3.90
SF	ALAMEDA	4451	60.31	729.07	17.31	0.00	46.95
	CONTRA COSTA	1180	15.98	193.28	4.60	0.00	12.44
	MARIN	282	3.82	46.19	1.09	0.00	2.97
	NAPA	161	2.18	26.37	0.62	0.00	1.60
	SAN FRANCISCO	2186	29.62	358.06	8.52	0.00	22.45
	SAN MATEO	684	9.26	112.03	2.66	0.00	7.52
	SANTA CLARA	1515	20.52	248.15	5.90	0.00	15.98
	SOLANO	242	3.27	39.63	0.94	0.00	2.55
	SONOMA	405	5.48	66.33	1.57	0.00	4.27
SJV	FRESNO	1418	19.20	232.20	5.50	0.00	14.90
	KERN	882	11.90	144.40	3.40	0.00	9.30
	KINGS	116	1.50	19.00	0.40	0.00	1.20
	MADERA	171	2.30	28.00	0.60	0.00	1.80
	MERCED	185	2.50	30.30	0.70	0.00	1.90
	SAN JOAQUIN	761	10.30	124.60	2.90	0.00	8.00
	STANISLAUS	681	9.20	111.50	2.60	0.00	7.10
	TULARE	591	8.00	96.80	2.30	0.00	6.20
SV	BUTTE	450	6.00	73.70	1.70	0.00	4.70
	COLUSA	17	0.20	2.70	0.00	0.00	0.10
	GLENN	18	0.20	2.90	0.00	0.00	0.10
	PLACER	164	2.20	26.80	0.60	0.00	1.70
	SACRAMENTO	1546	20.90	253.20	6.00	0.00	16.30
	SHASTA	275	3.70	45.00	1.00	0.00	2.90
	SOLANO	91	1.20	14.90	0.30	0.00	0.90
	SUTTER	79	12.90	0.30	1.00	0.00	0.80
	TEHAMA	76	1.00	12.40	0.20	0.00	0.80
	YOLO	254	3.40	41.60	0.90	0.00	2.60
	YUBA	59	0.70	9.60	0.20	0.00	0.60
TOTAL		39286	541.64	6419.21	151.11	0.00	412.03

Fraction of Reactive Organic Gases (FROG): .7500
 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
 Fraction of PM10 (FRPM10): .9800
 (PM10 Emissions = PM X FRPM10)

Table III
 1991 Area Source Emissions
 Activity: Unspecified Activities
 Process: Unplanned Fires
 Entrainment: Solid Material Combustion
 Dimn: Auto Body
 CES: 57307
 Process Rate Unit: Autos Burned

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	1	0.00	0.00	0.00	0.00	0.00
	INYO	3	0.00	0.00	0.00	0.00	0.00
	MONO	6	0.00	0.00	0.00	0.00	0.00
LC	LAKE	37	0.10	0.30	0.00	0.00	0.30
LT	EL DORADO	19	0.00	0.20	0.00	0.00	0.10
	PLACER	12	0.00	0.10	0.00	0.00	0.10
MC	AMADOR	23	0.00	0.20	0.00	0.00	0.10
	CALAVERAS	46	0.10	0.40	0.00	0.00	0.30
	EL DORADO	53	0.10	0.50	0.00	0.00	0.40
	MARIPOSA	18	0.00	0.10	0.00	0.00	0.10
	NEVADA	42	0.10	0.40	0.00	0.00	0.30
	PLACER	27	0.00	0.20	0.00	0.00	0.20
	PLUMAS	41	0.10	0.40	0.00	0.00	0.30
	SIERRA	6	0.00	0.10	0.00	0.00	0.10
	TUOLUMNE	67	0.20	0.70	0.00	0.00	0.50
NC	DEL NORTE	19	0.00	0.20	0.00	0.00	0.10
	HUMBOLDT	76	0.20	0.80	0.00	0.00	0.60
	MENDOCINO	84	0.30	0.80	0.00	0.00	0.70
	SONOMA	43	0.10	0.40	0.00	0.00	0.30
	TRINITY	5	0.00	0.00	0.00	0.00	0.00
NCC	MONTEREY	344	1.20	3.60	0.10	0.00	2.90
	SAN BENITO	17	0.00	0.10	0.00	0.00	0.10
	SANTA CRUZ	188	0.60	1.90	0.00	0.00	1.50
NEP	LASSEN	2	0.00	0.00	0.00	0.00	0.00
	MODOC	5	0.00	0.00	0.00	0.00	0.00
	SISKIYOU	20	0.00	0.20	0.00	0.00	0.10
SC	LOS ANGELES	12247	44.10	130.10	4.20	0.00	104.00
	ORANGE	2538	9.10	26.90	0.80	0.00	21.50
	RIVERSIDE	1399	5.00	14.80	0.40	0.00	11.80
	SAN BERNARDINO	1595	5.70	16.90	0.50	0.00	13.50
SCC	SAN LUIS OBISPO	177	0.60	1.80	0.00	0.00	1.50
	SANTA BARBARA	202	0.70	2.10	0.00	0.00	1.70
	VENTURA	584	2.10	6.20	0.20	0.00	4.90
SD	SAN DIEGO	2280	8.20	24.20	0.70	0.00	19.30
SED	IMPERIAL	101	0.30	1.00	0.00	0.00	0.80
	KERN	134	0.40	1.40	0.00	0.00	1.10
	LOS ANGELES	237	0.80	2.50	0.00	0.00	2.00
	RIVERSIDE	530	1.90	5.60	0.10	0.00	4.50
	SAN BERNARDINO	376	1.30	3.90	0.10	0.00	3.10
SF	ALAMEDA	1497	5.39	15.90	0.52	0.00	12.72
	CONTRA COSTA	1008	3.63	10.71	0.35	0.00	8.56
	MARIN	171	0.61	1.81	0.05	0.00	1.45
	NAPA	133	0.47	1.41	0.04	0.00	1.13
	SAN FRANCISCO	1053	3.79	11.88	0.36	0.00	8.94
	SAN MATEO	543	1.95	5.76	0.19	0.00	4.61
	SANTA CLARA	1420	5.11	15.08	0.49	0.00	12.07
	SOLANO	143	0.51	1.51	0.05	0.00	1.21
	SONOMA	271	0.97	2.87	0.09	0.00	2.30
SJV	FRESNO	1345	4.80	14.20	0.40	0.00	11.30
	KERN	850	3.00	9.00	0.20	0.00	7.20
	KINGS	120	0.40	1.20	0.00	0.00	1.00
	MADERA	170	0.60	1.80	0.00	0.00	1.40
	MERCED	228	0.80	2.40	0.00	0.00	1.90
	SAN JOAQUIN	799	2.80	8.40	0.20	0.00	6.70
	STANISLAUS	490	1.70	5.20	0.10	0.00	4.10
	TULARE	560	2.00	5.90	0.10	0.00	4.70
SV	BUTTE	239	0.80	2.50	0.00	0.00	2.00
	COLUSA	18	0.00	0.10	0.00	0.00	0.10
	GLENN	21	0.00	0.20	0.00	0.00	0.10
	PLACER	157	0.50	1.60	0.00	0.00	1.30
	SACRAMENTO	1877	6.70	19.90	0.60	0.00	15.90
	SHASTA	239	0.80	2.50	0.00	0.00	2.00
	SOLANO	54	0.90	0.50	0.00	0.00	0.40
	SUTTER	70	0.20	0.70	0.00	0.00	0.50
	TEHAMA	49	0.10	0.50	0.00	0.00	0.40
	YOLO	200	0.70	2.10	0.00	0.00	1.70
	YUBA	66	0.20	0.70	0.00	0.00	0.50
TOTAL		37395	132.73	395.33	10.84	0.00	314.99

Fraction of Reactive Organic Gases (FROG): .7500
 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
 Fraction of PM10 (FRPM10): .9970
 (PM10 Emissions = PM X FRPM10)